AUG 1 8 2004

Ms. Bonnie C. Gitlin, Acting Director
Radiation Protection Division
Office of Radiation and Indoor Air
Environmental Protection Agency
Center for Federal Regulation
M. S. 66080
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Concrete Block Size for the Explosion Isolation Wall of the Panel Closure
System

Dear Ms. Gitlin:

The purpose of this letter is to inform you that the Department of Energy (DOE) is
considering a change in the size of the concrete blocks used in construction of the
explosion isolation wall of the WIPP Panel Closure System. The design and
construction of the wall requires the use of solid concrete blocks measuring 8x8x16
inches, or as otherwise approved.

During construction of the explosion isolation walls for Panel 1, it was determined that
the weight of the blocks (72 – 75 pounds each) is problematic. Even with the
implementation of a comprehensive safety program there was one injury that was
attributed to the block weight. Beginning with Panel 2 the DOE will likely choose to
reduce the weight of some or all the blocks used to construct the explosion isolation
walls by using blocks of a smaller size.

To ensure that a smaller concrete block continues to meet the intent of the design
specification of the panel closure system, the effect of concrete block size on
operational and structural performance of the explosion isolation wall was evaluated.
This evaluation considered the use of 8x8x16 inch, 6x8x16 inch, or 4x8x16 inch solid
concrete blocks for the construction of the explosion isolation wall to determine if the
use of different block sizes would continue to comply with the design basis for the WIPP
panel closure system. This evaluation concluded that the effectiveness of the closure
system is essentially the same for all three block sizes. This evaluation has been
certified by a Professional Engineer registered in New Mexico and is enclosed with this
letter.

As you are aware, on October 7, 2002, the DOE provided the EPA a proposed change
request regarding modification of Condition 1 of the WIPP Certification Decision.

CBFO:OEC:RP:JGW:04-1708:UFC:5486

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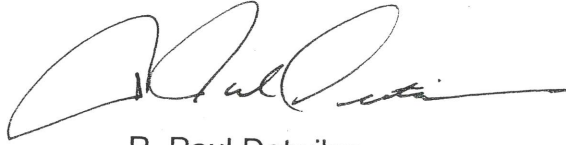
Condition 1 pertains to the design and construction of the WIPP panel closure system. This current information is provided in order to update the EPA with regard to waste disposal panel closure activities at the WIPP.

Sincerely,

R. Paul Detwiler
Acting Manager

Enclosure

cc w/enclosure:
B. Forinash, EPA
T. Peake, EPA
C. Byrum, EPA
N. Stone, EPA Region 6
J. Bearzi NMED
C. Chavez, NMED
S. Zappe, NMED

CBFO:OEC:RP:JGW:04-1708:UFC:5486

An Evaluation of the Effect of Concrete Block Size on
Operational and Structural Performance of Explosion Isolation
and Panel Closure Walls

Mine Engineering
Repository Development Project
Washington TRU Solutions LLC

May 20, 2004

Certification

I certify under penalty of law that this document was prepared under my supervision for Washington TRU Solutions, under the RockSol Consulting Group, Inc., Quality Assurance Program. This quality assurance program is designated to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Saeid Saeb, Ph.D., P.E.
New Mexico
Certification No, 11777
Expires December 31, 2005

Introduction

RockSol Consulting Group, Inc., under contract to Westinghouse (now Washington) TRU Solutions (WTS), prepared a detailed design for a revised panel closure system (hereafter the revised design) for the Waste Isolation Pilot Plant (WIPP). This revised design is described in a Design Report for a Revised Panel Closure System at the Waste Isolation Pilot Plant, October, 2002 (RockSol, 2002). The revised design uses a combination of a mortared concrete block wall and a run of mine salt backfill. With regard to concrete block size, the Technical Specifications, Section 03300, state the "Nominal modular size shall be 8x8x16 inches, or as otherwise approved by Westinghouse."

A "Notification of Planned Change" has been submitted to the EPA to address changes from the EPA's Option D Panel Closure System. A Class 3 Permit Modification Request (PMR) for a revision of the panel closure system design has been submitted to the New Mexico Environment Department (NMED). While the permit modification process for this Class 3 PMR is followed, an approved Class 1* Permit Modification allows the installation of only the Explosion Isolation Wall component of the permitted Option D configuration (hereafter the approved design) in Panel 1 for initial closure action, using materials specified in the revised design.

Explosion Isolation Walls were installed in the intake and exhaust drifts for Panel 1, May through July 2003. These walls were constructed using materials and tests specified in the revised design, which are higher and more stringent than those in the approved design. Their use ensures compliance with both the approved design and the revised design. During construction an item identified as a major safety concern was the weight of the 8x8x16 inch solid concrete blocks, which typically was 72-75 lbs. A very comprehensive safety program was prepared and only one injury, a back strain, occurred due to the block weight. However, it was obvious that a significant safety improvement could be made if the block weight could be reduced. The preferred method to reduce weight while retaining other desired properties is to reduce the physical size of the blocks.

While the Technical Specifications for the revised design include nominal dimensions for the blocks, the wording also permits some latitude in size, if approved by WTS. Approval to use a block size other than that nominally specified should be based on objective evidence that the wall will continue to meet operational and structural performance requirements. This report describes the evaluation of the performance and stability of the block wall component of both the approved design and the revised design using concrete block sizes of 4x8x16 inches and 6x8x16 · inches. These dimensions are also industry standard and would yield block weights of about 35 pounds and 55 pounds respectively.

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Design Evaluations

To evaluate the design of the revised panel closure system two types of analyses were performed: (1) those addressing the operational requirements, and (2) those addressing the material and structural requirements. The first group included air-flow analyses, advection analysis, and uncertainty analysis of air-flow. The second group included material compatibility evaluation, heat generation, explosion evaluation, stress analysis and fracture-propagation evaluation. This report describes the evaluation of the performance and stability of the block wall component of both the approved design and the revised design using concrete block sizes of 4x8x16 inches and 6x8x16 inches.

Operational Performance of the Panel Closure System

A change in the size of concrete blocks will affect the intrinsic permeability of the concrete block wall. This in turn may affect the operational performance of the panel closure system. To address this issue, a complete air-flow analysis as well as an uncertainty analysis was performed for each block size.

The intrinsic permeability of concrete block wall was calculated for different sizes of concrete blocks. The results are summarized in Table 1. It can be observed that reducing the size of concrete blocks slightly increases the intrinsic permeability of the block wall.

Block Dimensions (in)	Intrinsic Permeability of Block Wall (m^2)
8x8x16	1.63×10^{-15}
6x8x16	2.00×10^{-15}
4x8x16	2.73×10^{-15}

Table 1. Intrinsic Permeability of Block Walls for Different Block Sizes

Air-Flow Analysis

The air-flow analysis was used to predict the expected mass flow rate for VOCs of concern through the panel closure system. The analysis was performed for concrete block walls made of different block sizes. The effective intrinsic permeability of the panel closure system was evaluated based on the intrinsic permeability of block wall (Table 1) and was used as input to the air-flow model to assess VOC flow performance.

Figure 1 shows the expected mass release rates for Carbon Tetrachloride versus time for different block sizes. The results are compared with that of the unrestricted flow model, as well as the E-300 drift mass release limits for the repository. As can be seen in the figure, the mass flow rate slightly increases by reducing the size of concrete blocks. However, the mass flow rate over the operational period is at least two orders of magnitude below the Hazardous Waste Facility Permit (HWFP) required health-based migration limit established at the E-300 drift, irrespective of block size.
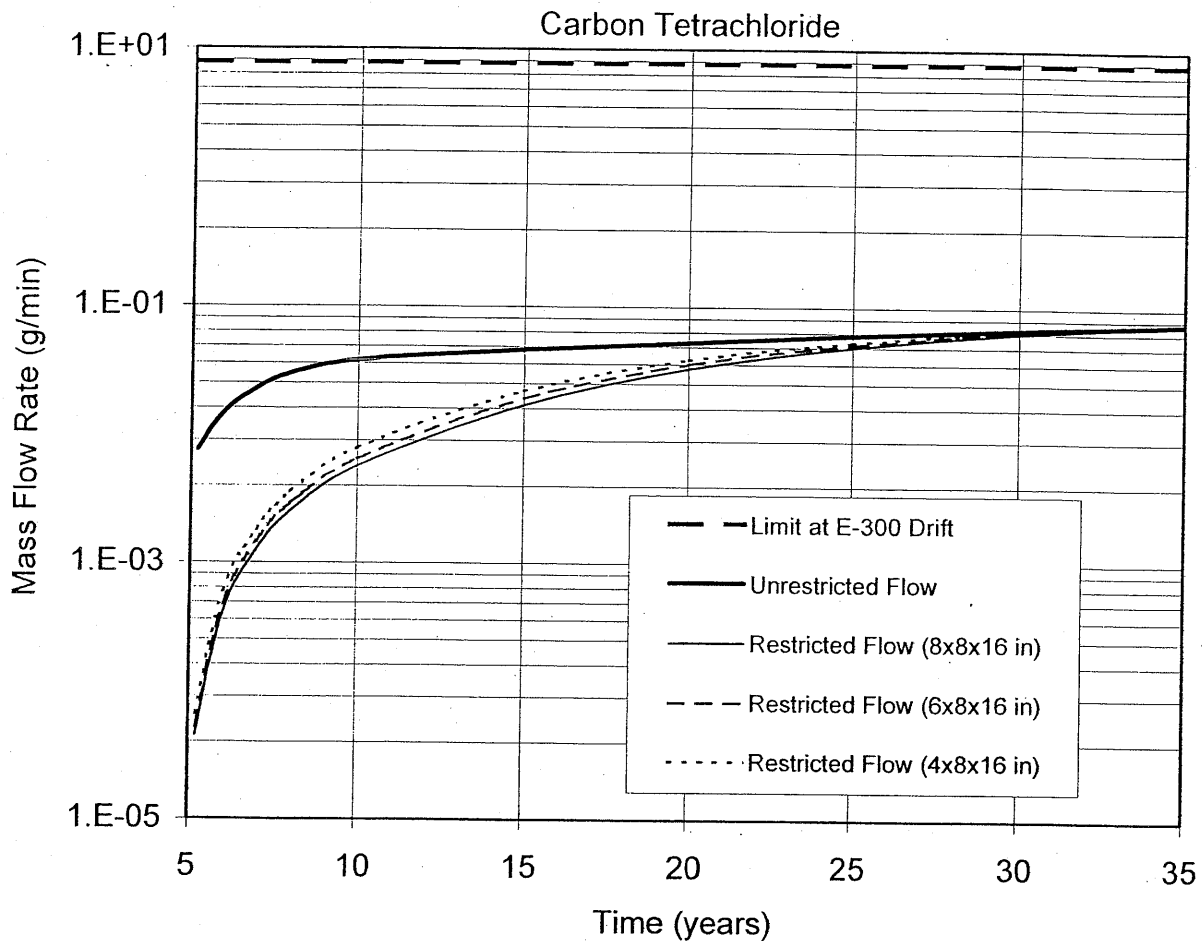
Figure 1. Migration Rates versus E-300 Drift Limit Values for Carbon Tetrachloride

Monte Carlo Simulation of VOC Release

This section presents the results of three Monte Carlo Simulation Analyses for mass flow rate of carbon tetrachloride over 35 years of operation. The Monte Carlo Simulations were performed for different block sizes. Carbon tetrachloride was used as a surrogate for all VOCs of concern since it is likely to be present in the greatest concentration in a closed panel.

The uncertain input parameters for all cases include:

- intrinsic permeability of various flow components;
- molar gas generation rate;
- panel volume closure rate; and,
- headspace concentration of different VOCs.

Except for the intrinsic permeability of concrete block wall, the ranges of all uncertain parameters were considered the same for the three simulations. The different ranges of intrinsic permeability of concrete block wall selected for the Monte Carlo Simulation are presented in Table 2.

Block Dimensions (in)	Lower Value (m^2)	Upper Value (m^2)
8x8x16	1.00×10^{-17}	1.00×10^{-13}
6x8x16	1.20×10^{-17}	1.20×10^{-13}
4x8x16	1.65×10^{-17}	1.65×10^{-13}

Table 2 Ranges of Intrinsic Permeabilities of Concrete Block Wall

The results of the three simulations for 60 different realizations are presented in Figure 2. The figure shows the variation of mass flow rate for carbon tetrachloride during the operational life of the panel closure system. The ranges for mass flow rate of carbon tetrachloride after about 35 years are shown in Table 3. The results show that even for the case of the extreme value distribution, the mass release rate of Carbon Tetrachloride is nearly two orders of magnitude below the E-300 limit. In fact, with few exceptions, it is impossible to distinguish between the results for the different block sizes.
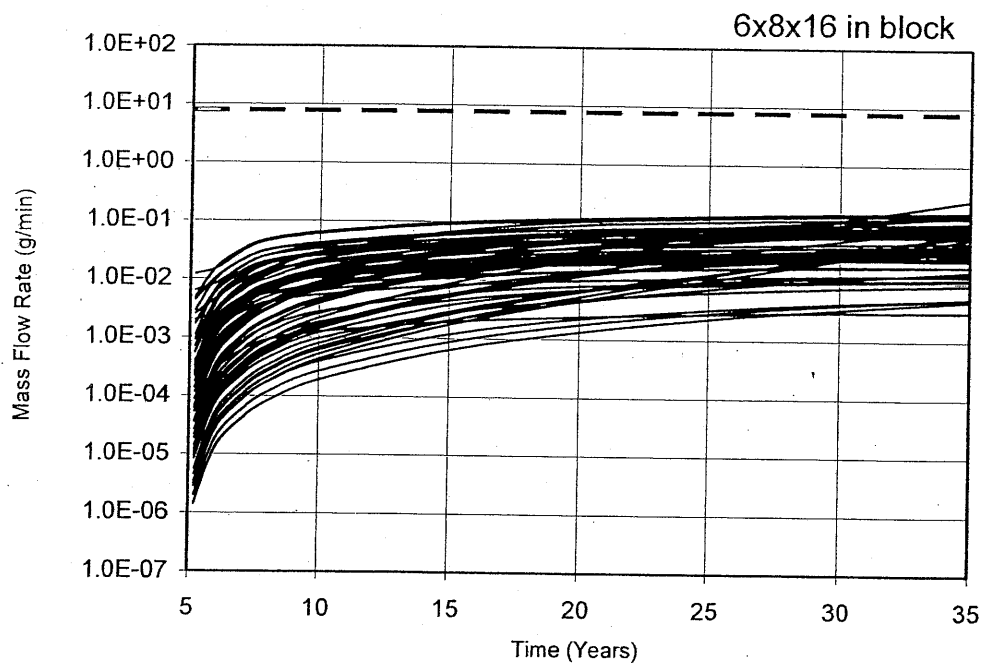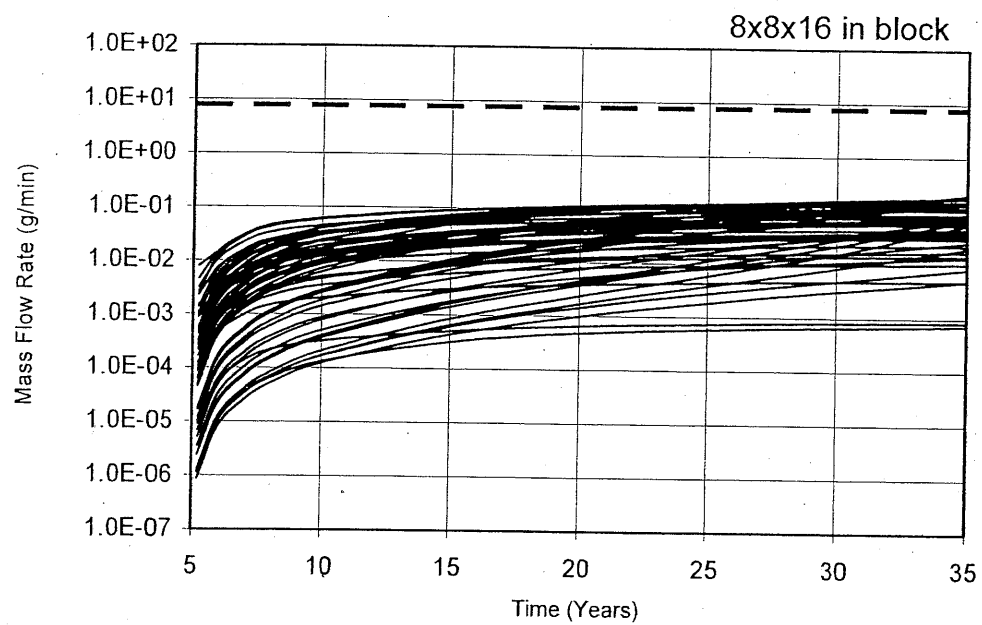
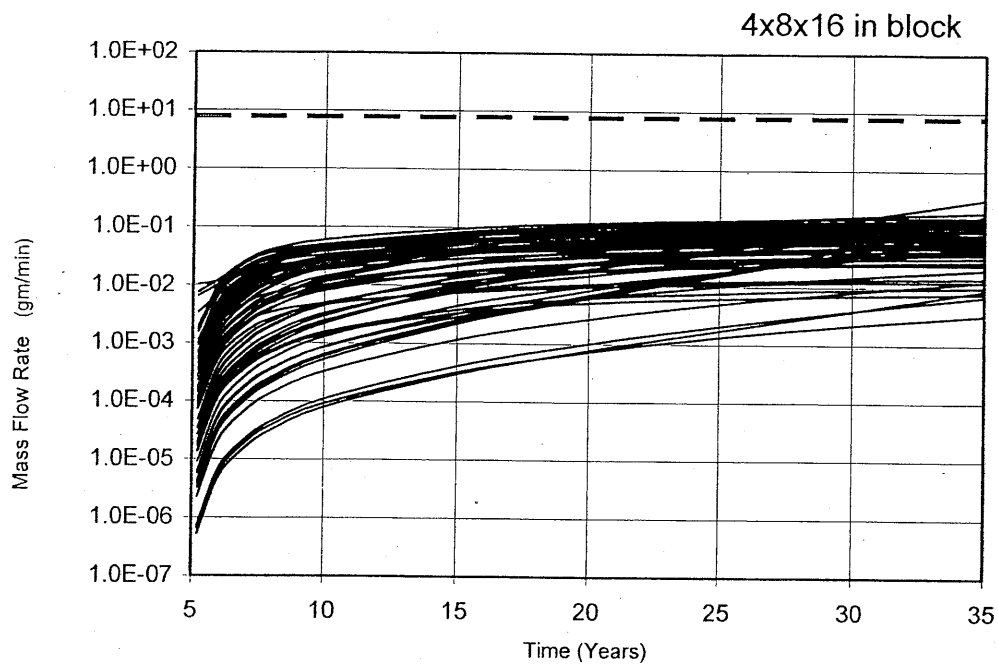**Figure 2** Monte Carlo Simulation of Mass Flow Rate for Carbon Tetrachloride

4x8x16 in block

Figure 2 (continued) Monte Carlo Simulation of Mass Flow Rate for Carbon Tetrachloride

Block Dimensions (in)	Lower Value (g/min)	Upper Value (g/min)
8x8x16	0.0007	0.1998
6x8x16	0.0031	0.2521
4x8x16	0.0032	0.3211

Table 3 Ranges of Mass Flow Rate of Carbon Tetrachloride after about 35 Years for Block Walls with Different Block Sizes

Structural Stability of the Panel Closure System

The stress analyses conducted for the revised design and the Option D explosion isolation wall using revised design material parameters evaluated the interaction of the block wall with the surrounding salt. Stresses are expected to develop in the block wall component due to continued creep closure of the air-intake and air-exhaust drifts after the installation of the block wall. Stresses are also expected to develop in the run of mine backfill due to creep closure, although at a very much slower rate than in the block wall. Further, it was shown that these walls can withstand the postulated methane explosion.

In order to investigate the behavior of the components under creep loading and combined creep and explosion loading, a detailed two-dimensional, axisymmetric representation of the closure system was developed using the FLAC (Itasca, 2000) computer code. A variety of different cases were run with different loading and strength properties as called for by ACI Ultimate Strength Design Method. The block wall was given a minimum compressive strength of 5000 psi (34.5 MPa). This analysis uses the strength of the block wall as an integral structure and does not model concrete blocks and mortar joints as discrete entities.

The intent of Technical Specifications for the revised design is to ensure that the block wall, as constructed, meets this strength. In addition to specifying various material properties, the Technical Specifications also require quality control inspections and testing during the construction to ensure that the block wall as constructed will perform as calculated. Therefore changing the block size will not affect the structural analyses as long as the intent of the Technical Specifications is maintained.

The results from the ultimate strength design cases for the revised design showed that while some compressive failure occurs near the ends of the block wall, the wall maintains a sizable intact confined core in every case. This analysis shows that the wall will perform its required function throughout the nominal operational design life. Similarly, the Option D explosion isolation wall will also perform as required in the approved design and for a period of at least 5 years. Therefore a block wall consisting of 8x8x16 inch, 6x8x16 inch or 4x8x16 inch solid concrete blocks meeting the other requirements of the Technical Specifications will perform its intended function for the nominal operational design life.

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Conclusions

A Panel Closure System or an Explosion Isolation Wall component constructed of 8x8x16 inch, 6x8x16 inch or 4x8x16 inch solid concrete blocks complies with all aspects of the design basis established for the revised WIPP panel closure system. To investigate the effect of changing block dimensions, several key design evaluations were performed. The conclusions reached from the evaluations are:

- The mass flow rates for different VOCs through the PCS are substantially below the limits established in the HWFP for the E-300 drift, irrespective of block size.

- The Monte Carlo Simulation Method was used to assess the uncertainty of VOCs headspace concentrations, gas generation rates, and panel volume closure rates on the mass flow rate of carbon tetrachloride. The results show that the effectiveness of the closure system is essentially unchanged, irrespective of block size.

- The structural analysis described in the detailed design considers the block wall as an integral structure and does not model concrete blocks and mortar joints separately. Therefore changing the block size will not affect the structural analysis described in the detailed design report as long as the intent of the Technical Specifications is achieved.

References

RockSol, 2002, Design Report for a Revised Panel Closure System at the Waste Isolation Pilot Plant

Itasca Consulting Group, Inc. (Itasca), 2000, "FLAC User's Manual," Itasca Consulting Group, Inc., Minneapolis, Minnesota.